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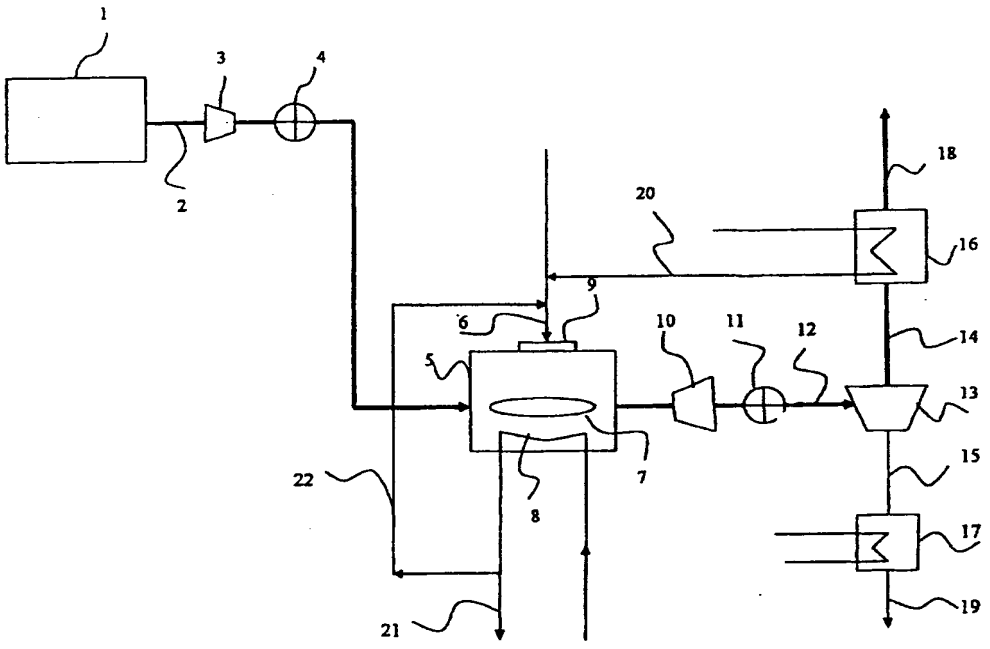
(54) Title: METHOD AND DEVICE FOR SLAKING LIME MATERIAL



(57) Abstract: A method and a device for slaking quick lime material or other material that can be slaked, is distinguished in that quick lime material or the corresponding is brought into contact with water vapour in a slaking step, whereby slaked lime or the corresponding is formed and energy that is generated by condensation of steam and at hydration is recovered.

WO 02/096820 A1

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD AND DEVICE FOR SLAKING LIME MATERIAL

Field of the invention

The present invention concerns a method and a device for slaking quick lime (CaO), or other slakable materials with water vapour during recovery of energy.

Description of prior art

In sulphate pulp plant digester chemicals such as white liquor, which essentially comprises sodium sulphide and sodium hydroxide, are recovered through causticising of green liquor. Green liquor contains i.a. sodium carbonate in a water solution, which is converted to sodium hydroxide through the addition of slaked lime:

$$Na_2CO_3\ (aq) + Ca(OH)_2\ (s) \rightarrow 2NaOH\ (aq) + CaCO_3\ (s)$$

At causticising a residual product is obtained of lime sludge and including calcium carbonate, which after dewatering (mechanical and possibly thermal) is heated whereby carbon dioxide escapes and calcium oxide is formed (calcination):

$$CaCO_3\ (s) + \text{heat} \rightarrow \leftarrow CaO\ (s) + CO_2\ (g)$$

At calcination is usually employed a lime sludge oven, which is formed as a long (usually 70-100 m) tubular masonry oven which is slightly inclined and slowly rotating. Inside the oven there are different temperature zones where drying, preheating, calcination and sintering take place. Heat is usually supplied through burning of oil. The hot fumes are led in counter-flow against the solid material through the oven. Calcination occurs at about 900°C. Drying may also be made in an external dryer. This is usually made when there is a desire

to increase a capacity of an already operational lime sludge oven.

After the calcination zone, the temperature is raised to against or above 1100° where the quick lime sinters. The quick lime is then slaked with green liqueur in a slaking vessel, whereby hydration heat (q_r) is emitted:

$$Cao\ (s) + H_2O\ (liq) \rightarrow Ca\ (OH)_2\ (s) + q_r$$

The slaked lime is subsequently used for the above described causisicing process, where the green liqueur is recovered as white liqueur. In the lime cycle there are further several filtering and washing steps which are not described here.

The slaking process may be pressurised or operate at atmospheric pressure. The technology with pressurised slaking with green liqueur and recovery of heat is described in TAPPI Proceedings (ISSN 0272-7269)1985 International Chemical Recovery Conference and in Svensk Papperstidning nr 18, 1986. The atmospherical technology, which is the prevailing one, only gives the possibility of recovering heat at relatively low temperature level as for example so as to heat white liqueur and/or produce hot water. In many plants the need of hot water can be met in any other way. In cases where quick lime is mixed with green liqueur under pressure there is, however, a possibility also to produce steam. The hereby produced steam is of a lower pressure and temperature then what is possible to obtain in connection with the present invention.

The aim and most important features of the invention

An aim with the present invention is to provide a method and a device for slaking quick lime with steam of the kind mentioned

above, whereby the drawbacks of the prior art are avoided and it is possible to recover more heat, and this at a higher temperature and thereby obtain better economy.

This aim is obtained in a method and a device as above through the features of the characterizing portions of the respective claims 1 and 15.

The present invention concerns a method and a device for slaking quick lime material or other materials that may be slaked with steam (water vapour) and in connection with slaking recover energy and use waste heat in an energy effective manner. With slaking is intended hydration in an exothermal reaction. With lime raw material is intended calcium carbonate containing minerals or substances for example lime sludge, limestone, dolomite, calcium containing sludge. The lime raw material often also contains other elements than calcium as natural contents or as additives. Naturally also steam-gas mixtures or water in liquid form be used for slaking. With steam-gas mixtures is intended dry water vapour mixed with air or other gases.

According to the invention water vapour or water vapour-gas mixtures are used for slaking quick lime raw material. The quick lime reacts with water vapour in gaseous phase and forms calcium hydroxide. The released hydration heat (q_r) can thereby be useful for recovering energy at a high temperature level, which is an economic and technical advantage compared with today's technology. By slaking with steam, a greater amount of heat can thereby be recovered since the condensation heat (q_c) of the water vapour is taken care of, compared to traditional slaking with water in liquid form. Slaking thus is carried out according to:

$CaO(s) + H_2O(g) \rightarrow \leftarrow Ca(OH)_2(s) + q_r + q_c$

In order to generate water vapour for slaking, waste heat may advantageously be used.

Further it is exploited that only that amount of water is added that corresponds to the requirement at the slaking reaction as a contrast to the traditional slaking where water is present in a great excess. The traditional slaking usually takes place at a temperature around 100°C. That low temperature results in that the heat that may be recovered is less useful.

There is an advantage if the quick lime which has a higher temperature when it is discharged from the lime sludge oven, immediately be brought into the slaking reactor. In this way also the heat of the quick lime is utilized (sensible heat).

Heat recovery in the device according to the invention is very good because of preferred use of a slaking reactor with recovery possibilities and heat exchanges of all flows. The heat can be recovered at high temperature for example as steam of relatively high pressure and temperature in a steam boiler without the slaking reactor having to be pressurised. Generated heat in the form of steam may be used, as a whole or partly, as steam in the slaking reaction. If pressurized steam is generated, process steam or power may be produced. Power may suitably be produced in power generators as for example in a turbine.

Steam for the slaking reaction may also be, entirely or partly, recovered through heat exchange with outgoing hot material streams.

According to one embodiment of the invention, the slaking reactor may be integrated with a dryer for drying the lime raw material. Recovered energy from the slaking reactor can then be used as heat carrier in the dryer. The moist given from the dryer forms steam or steam gas mixture that can be used for the slaking reaction.

The slaker can also be designed such that an excess of steam or steam-gas mixture is obtained. This excess of steam or steam-gas mixture from the slaker may be used as drying medium when drying the lime raw material.

Also from an environmental point of view the present invention is advantageous. Firstly the reaction takes place in one or plural slaking reactors which are comprised of closed vessels. When the slaking takes place, no or very small discharges to the environmental air occurs.

The slaking reactor is hereby preferably provided with devices for feeding and discharge of the solid material and with sluice devices preventing leakage inwards and outwards.

Many conventional lime sludge ovens at the plants are today overloaded because of the high costs for renewing or extending lime sludge ovens. Overload brings about unnecessarily great oil consumption. By equipping such a lime sludge oven with a slaking reactor, wherein the slaking takes place with water vapour, the need to sinter the lime may be diminished whereby a further part of the lime sludge oven could be used for calcination for increased capacity. This also contributes to increased economy. Further, enhanced control and regulation of the lime sludge oven is achieved since one process operation (sintering) can be disposed of.

Brief description of drawings

Further advantages that are obtained in using the present invention is clear from the following detailed description, wherein it is referenced to the annexed drawings, wherein:

figure 1 diagrammatically shows the device for slaking using water vapour and heat recovery and use of waste water according to the invention.

figure 2 diagrammatically shows the device where a dryer for drying lime raw material is connected before a slaking reactor.

Description of embodiment

Figure 1 shows a device for slaking using water vapour and with heat recovery and the use of waste water including a lime sludge oven 1, where heat is supplied through burning a fuel with air, and to which lime sludge (lime raw material) is supplied in an optional manner for calcination.

From the lime sludge oven, hot quick lime is conveyed over the conduit 2 with the aid of a feeding device 3 over a sluice device 4 to the slaking reactor 5. To this reactor is also brought water vapour, over the conduit 6. Inside the reactor, the quick lime reacts with water vapour under strong heat generation and forms slaked lime which is calcium hydroxide. Inside the slaking reactor there is also a contact member 7 enhancing the contact between quick lime and water vapour. The contact member may for example be comprised of an agitator.

Inside the slaking reactor there is a heat exchange 8 for recovering energy. Water vapour is brought over an inlet means 9, which can be comprised of tubes, valves and distributing equipment of the slaking reactor.

The slaked lime is in solid form when it is fed out from the slaker with a discharge device 10 over the sluice device 11. Thereafter the conduit 12 leads to a separator 13, wherein solid material may be separated from gaseous material. The energy in the material streams after the separator 13 may be recovered. Slaked lime is brought over the conduit 14 to the heat exchanger 16 and the cooled slaked lime exits over the conduit 18. Gaseous material being separated in the separator 13 is brought over the conduit 15 to the heat exchanger 17, whereafter gases are conveyed further through the conduit 19. Inside the heat exchanger 16 steam may be produced which is brought over the conduit 20 to the slaking reactor.

In figure 1 it is also shown how steam or hot water may be recovered from produced heat in the heat exchange 8. The steam/hot water may be used for process uses and be led away over the conduit 21. If steam is produced it can also, entirely of partly, be re-cycled over the conduit 22 to the slaking reactor 5 and be used in the slaking reaction.

Figure 2 shows an application where before the slaking reactor 5 there is connected a dryer 24 wherein the lime raw material is dried. Steam produced when drying the lime raw material is led through the conduit 25 to the slaking reactor 5. Inside the dryer 24 there is a heat exchanger 26 where steam produced in the heat exchanger 8 is brought in over the conduit 27 and is used as heat carrier. Condensate which has been formed at the drying is led over the conduit 28 to the heat exchanger 8 in the slaking reactor 5. For the slaking process can also be used, entirely of partly, steam of another origin, and that steam is in that case supplied over the conduit 29.

The invention may be modified within the scope of the claims.

The slaking reaction according to this invention can be combined, advantageously, with a method for calcination using a gas plasma of carbon dioxide, which is brought into contact with lime raw material in a reactor. In combination with such a calcination method, several advantages are obtained which has to do with extended heat recovery.

The slaking reactor and associated equipment may suitably be provided with separators such as cyclones in order to separate the lime from gaseous substances.

The invention may be used with or without pressurising or without separating devices and with a varying number and positions of heat exchangers.

CLAIMS

1. Method for slaking quick lime material or other material that can be slaked, whereby quick lime material or the corresponding is brought into contact with water vapour, whereby slaked lime or the corresponding is formed, **characterized in** that energy is recovered at the slaking reaction and that steam and/or hot water is produced with the aid of the recovered energy.

2. Method according to claim 1, **characterized in** that slaking takes place with steam-gas mixtures.

3. Method according to claim 1, **characterized in** that the slaking takes place in a slaking reactor into which is brought water in liquid form that will vaporize, and the subsequent slaking of the quick lime raw material takes place with the formed water vapour.

4. Method according to any of the claims 1 - 3, **characterized in** that quick lime which is produced through calcination of lime sludge is slaked.

5. Method according to any of the claims 1-4, **characterized in** that the slaking takes place in one or plural slaking reactors.

6. Method according to any of the previous claims, whereby steam is produced, **characterized in** that at least part of produced steam is used for slaking.

7. Method according to any of the previous claims, **characterized in** that water vapour or water vapour-gas mixtures generated when drying lime raw material is used for slaking.

8. Method according to any of the previous claims, **characterized in** that water vapour generated at heat exchange with material streams emanating from the slaking, is used for the slaking.

9. Method according to any of the previous claims, **characterized in** that water vapour which is produced through heat exchange at slaking may be used for the slaking after expansion in a turbine.

10. Method according to any of the previous claims, **characterized in** that pressurised water vapour or pressurised water vapour-gas mixtures are used for the slaking.

11. Method according to any of the previous claims, **characterized in** that part of the water vapour which is recovered at the slaking is used as heat supply at drying of the lime raw material.

12. Method according to any of the previous claims, **characterized in** that part of the water vapour which is recovered at slaking or a water vapour-gas mixture is used as drying medium when drying the lime raw material.

13. Method according to any of the previous claims **characterized in** that the slaked lime is separated from the gaseous substances in one (or plural) separator(s).

14. Method according to any of the previous claims **characterized in** that it is combined with a method for calcination using a gas plasma of carbon dioxide, which is brought into contact with lime raw material.

15. Device for slaking quick lime raw material or any other material that can be slaked, **characterized in** that it includes at least:
- one slaking reactor (5) wherein the lime raw material or the corresponding is arranged to be brought into contact with water vapour for forming slaked lime or the corresponding,
- one heat exchanger (8) positioned in the slaking reactor (5) for recovering of energy.

16. Device according to claim 15, **characterized in** that it includes a feeding device for supply of lime raw material to the slaking reactor (5).

17.Device according to claim 15 or 16, **characterized in** that the slaking reactor (5) includes a contact member (7) for providing good contact between the lime raw material and the water vapour medium.

18. Device according to any of the claims 15 - 17, **characterized in** that it includes a discharge device for discharge from the slaking reactor (5).

19. Device according to any of the claims 15 - 18, **characterized in** that it includes an inlet means (9) for supply of water in liquid form, water vapour and/or water vapour gas mixtures to the slaking reactor (5).

20. Device according to any of the claims 15 - 19, **characterized in** that it includes one or plural heat exchangers (16, 17) which is (are) positioned after the slacking reactor (5) for energy recovery through heat exchange from hot material flows emanating from the slaking reactor (5).

21. Device according to any of the claims 15 - 20, **characterized in** that it includes one or plural slaking reactors (5) which operate with one or several different pressures or at an under pressure.

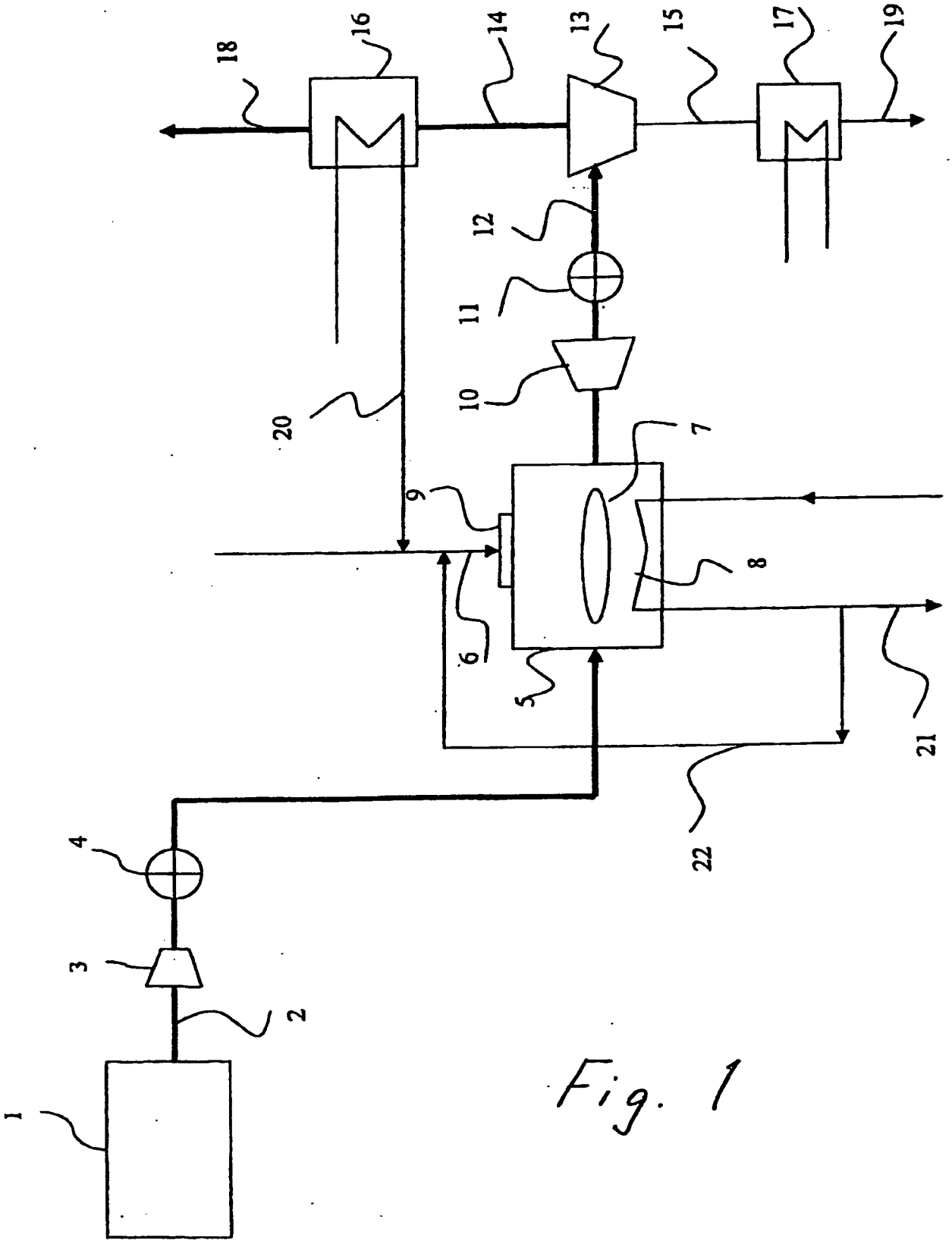
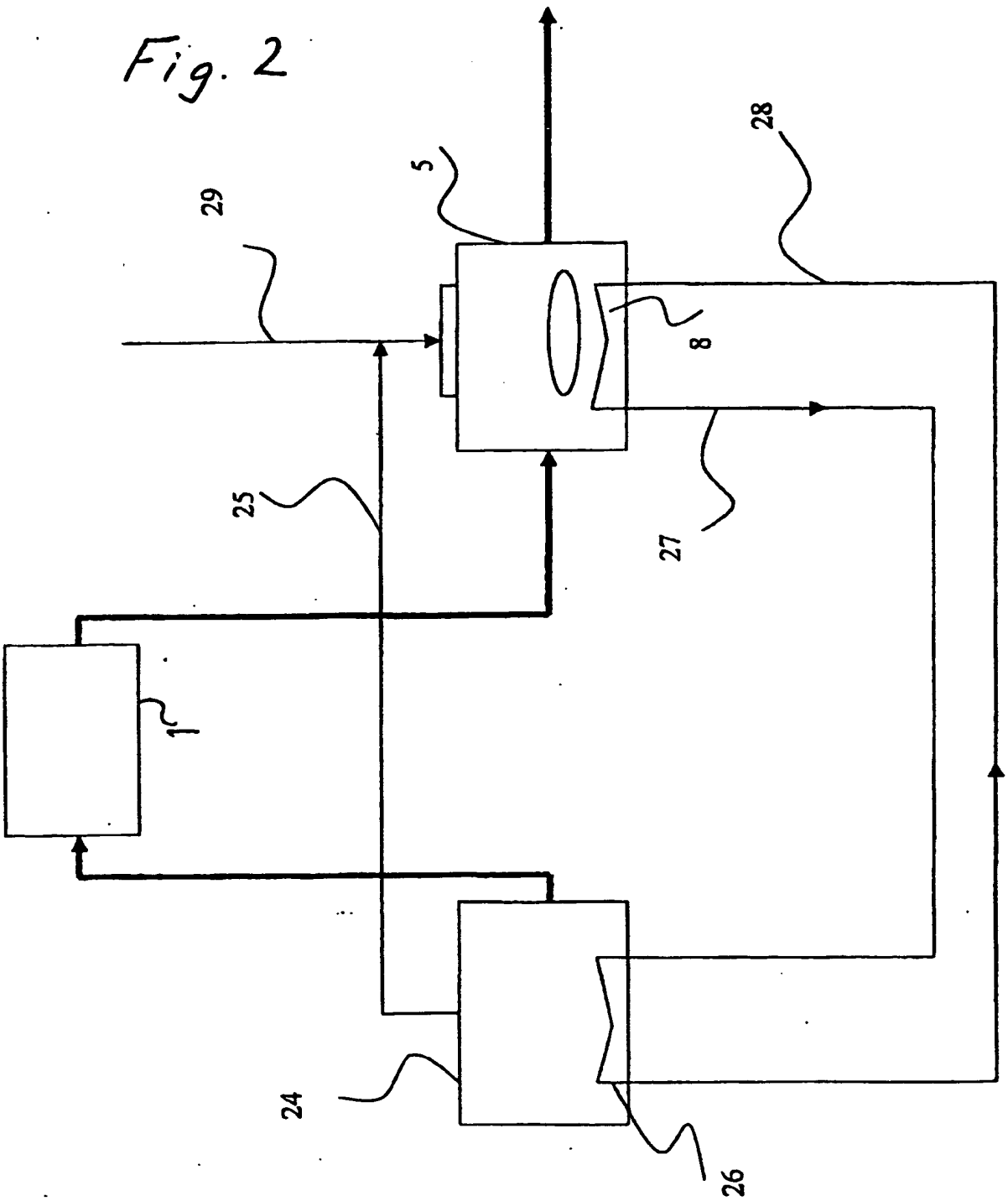


Fig. 1

Fig. 2



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/01034

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: C04B 2/00, C04B 2/04
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: C04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI DATA, EPO-INTERNAL, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	--	14
Y	US 3630504 A (JACK B. REYNOLDS), 28 December 1971 (28.12.71), column 1, line 28 - line 57, figures 1-2, abstract	1-13,15-21
A	--	14
A	US 4382911 A (ANTHONY R. PENNELL ET AL), 10 May 1983 (10.05.83), column 1, line 49 - line 51, abstract	1-21
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 August 2002	06 -09- 2002
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Ulrika Nilsson/MP Telephone No. +46 8 782 25 00

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International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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06/07/02

International application No.
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